ORIGINAL RESEARCH

INFLUENCE OF APICECTOMY MODALITIES ON APICAL SEAL OF RESIN-OBTURATED ROOT CANALS

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ABSTRACT

Background: Apical seal helps preventing apical leakage following apicectomy. Aim: To investigate the influence of apicectomy modalities on apical seal of root canals obturated with resin-based system. Materials and Methods: Root canals of 60 extracted premolars were prepared and obturated in 6 groups using RealsealSE sealer-points system. The teeth were divided into 6 equal groups according to apicectomy procedures. Group1 (obturation, immediate apicectomy, glass-ionomer retro-filling), Group2 (obturation, apicectomy after 24 hours, no retro-filling), Group3 (obturation, immediate apicectomy, light-curing of the sealer at the cut-surface), Group4 (obturation, immediate apicectomy, no apical-sealer light-curing), Group5 (apicectomy, obturation, apical-sealer light-curing), Group6 (apicectomy, obturation, light-curing of apical sealer coat). Specimens in all groups were subjected to dye leakage and longitudinal sectioning test. The collected data were statistically analyzed. Results: Both G1 (control) and G6 recorded comparable leakage possibility that was the lowest among test groups. Leakage values of groups 3 and 5 were also comparable and lower than groups 2 and 4. Leakage values of group 4 were the worse among all groups. Conclusion: Apical sealing with a selfetch adhesive sealer coat is an acceptable alternative to retrograde filling in resin-obturated canals. Light-curing of the sealer exposed following apicectomy might improve the apical seal.

Key words: apicectomy, adhesive sealers, leakage, retrograde filling

INTRODUCTION:

Management of the resected root end during periradicular surgery is critical to a successful outcome.⁴ The goal of periradicular surgery is to access the affected area, remove the diseased tissue, and place a biocompatible seal. This sealing material should stimulate cementum deposition and re-establishment of periodontal attachment as a desired healing response.² Resection of the root end results in an exposed dentinal root face surrounded peripherally by cementum with a root canal in the middle. Favorable healing response is characterized by a biological seal formed by cementum fill from the circumference of the resected root-end to the center added to the physical seal of the root end filling forming a double seal.³

An ideal root-end filling material should promote periradicular tissue healing through its tolerability and adherence to retrograde cavity walls.⁴ ⁵

Too many solid and plastic filling materials have been used for retro-grade cavity filling. Solid fillings include silver, tin and titanium posts, amalgam and gallium alloys. Plastic fillings include sealers such as calcium hydroxide and epoxy resin sealers and cements such as zinc phosphate, polycarboxylate, ZOE, IRM, Super EBA, MTA, calcium phosphate,
bone cements and gutta-percha. Composite resin is also commonly used as a retro-filling material. Ceramic inlays, teflon, a mixture of sulfathiazole and powdered dentin, cyanoacrylates, citric acid demineralization and laser are less commonly used alternatives.\textsuperscript{(6-11)} Glass ionomer showed good marginal sealing capacity in vitro, and has been found to offer excellent biocompatibility.\textsuperscript{(12,13)} Compomers has been proved to have better biocompatibility than ordinary glass ionomer cements and MTA and was suggested as the material of choice in root resorption, perforations, and root-end filling.\textsuperscript{(14)}

There has long been a debate on whether a root-end filling should always be placed to achieve a better apical seal.\textsuperscript{(15,16)} So, this in vitro study was conducted to investigate the influence of different apexectomy modalities on the apical seal of root canals obturated with RealSeal SE sealer-points system

Materials and Methods

Sixty single-canaled human mandibular premolars with straight root canals, freshly extracted from persons with age group 20 to 45 years old were selected for this study. Teeth were radiographed to ensure root integrity and canal patency and then stored at room temperature in physiological saline solution. Teeth with immature apices, cracks, and caries were excluded from the study. Soft tissue remnants and calculus were removed using ultrasonic scalers. The teeth were decoronated using a diamond disc (Edenta AG, AU/SG, Switzerland) under water cooling to standardize the remaining root length to 16 mm. The working length was established using #15 K-file (Dentsply, Maillefer, Ballaigues, Switzerland). The file was introduced through root canals until its tip was visible at the apical foramen. The actual working length was then determined to be 1mm shorter than the length of the used file.

All root canals were prepared with a series of k-files using step back technique. The apical preparation was standardized to master apical file # 40 and the stepping back procedure was continued till K-file # 60. The coronal flaring was done using gates glidden drills (Union Broach, New York, NY) size 1.2&3. During root canal preparation, 2ml of 2.5% sodium hypochlorite solution was used for irrigation after each file. After canal preparation, the root canals were conditioned with 10 ml of 17% EDTA (Canal +, Septodont, France) for 60 seconds for smear layer removal, followed by washing using 10 ml of 5.25% NaOCl. Finally root canals were flushed with 10 ml saline solution and dried with paper points (Dentsply-Maillefer, Ballaigues, Switzerland).\textsuperscript{(19)}

Grouping

The prepared roots were thereafter randomly divided into 6 groups (n=10) according to the modality of apicectomy procedures.

G.1 (control) - G.4: RealSeal Self-Etch sealer / Realseal point obturation was done first followed by resection of the apical 3mm of the roots.

Size 40 master Realseal point (0.02 taper) was seated to check the tug-back into the prepared canal and confirmed with periapical radiograph. To standardize the consistency of the sealer, predetermined amount, 1cm long, of the self-etching adhesive Realseal SE sealer (SybronEndo, Basicweg, Amersfoort, The Netherlands) was thoroughly mixed with one drop of thinning liquid on a graduated mixing pad. The master cone was used to apply the mixed sealer against the prepared canal walls using slight pumping motion twice before seating the cone to the full working length. Lateral condensation was carried out using a finger spreader (Dentsply, Maillefer, Ballaigues, Switzerland). The rest of the canal space was filled with laterally condensed auxiliary RealSeal points. The excess points were cut off using a heated hand plunger (Dentsply, Maillefer, Ballaigues, Switzerland) followed by vertical condensation. Excess sealer was removed with alcohol-soaked cotton pellet. A check radiograph was then taken to ensure complete canal filling and the coronal surface of the obturation was light cured using a curing light (HiLux LED 550; Benlioglu Dental, Ankara, Turkey) with an output of 1000 mW/cm2 for 40 seconds to create an immediate coronal seal. After root canal obturation, their apical 3mm were resected using a high-speed handpiece with water coolant and a fissure bur (Dentsply/Maillefer). The resected root-ends were smoothed with a double-sided carborundum disk (Dentorium Export Ltd, New York, NY, USA).\textsuperscript{(20,21)} and received different kinds of treatments as follows:

G.1(control): the root resection was done immediately after obturation followed by preparation of a small cavity at the apical end of the root canal by a rotating # 4 slow speed round bur (Dentsply/Maillefer) to 2mm depth into the canal followed by filling this cavity with compoglass F (Ivoclar Vivadent AG, Schaan/Liechtenstein).\textsuperscript{(22)} (Fig. 1,2)\textsuperscript{(23)}

G.2: obturation, apicectomy after 24 hours, no further apical treatment.

G.3: obturation, immediate apicectomy, light-curing of the sealer exposed at the cut-surface.

G.4: obturation, immediate apicectomy, no further apical treatment.

G.5 & G.6: surgical resection of the apical 3mm of the root was done first followed by RealSeal Self-Etch sealer / RealSeal point obturation using the
same technique with the only exception that the extruded realseal points through the resected apices were cut off using a hot hand plugger.

*In G.5:* the sealer exposed at the cut root surfaces was thereafter light-cured.

*In G.6:* a thin sealer coat was thereafter rubbed over the cut root surface using a small brush followed by light curing (Fig. 3).

![Fig. 1: Digital radiograph showing resected root apices(a), retrograde cavity depth(b) & root end filling(c)](image)

![Fig. 2: Retrograde Cavity Before & After Filling](image)

![Fig. 3 Resected root with apical sealer coating](image)

Leakage testing

Root surfaces were coated with two layers of nail varnish except the apical 2 mm. The apex of each resected root was subsequently immersed uprightly in freshly prepared 2% methylene blue dye solution for 72 hours at 37 °C. (23)

Teeth were then rinsed in tap water to remove excess dye, nail varnish was removed with scalpel blade and two longitudinal grooves were prepared on the lingual and buccal surfaces of each root with a diamond disc under water-cooling. Each root was then split longitudinally into two halves using a chisel and hammer. The teeth were then dried, coded and the root fillings were removed to detect the maximum coronal linear dye penetration from the apical cut end in both halves of each split root (Fig. 4). (24) Maximum linear dye penetration was measured in mm using a graduated ruler and a magnifying lens.

Statistical analysis:

The mean values of apical leakage of experimental groups with the standard deviation were calculated and analyzed statistically using 1-way analysis of variance (ANOVA). Sceffe’s test was performed to pick up the site of statistical significance at $\alpha = 0.05$. Furthermore, Tukey’s comparisons at $\alpha = 0.05$ was done to stand on the significance of differences between test groups.

RESULTS

The mean leakage measurements and their statistical values were shown in tables 1 and 2. One-way ANOVA test indicated some differences in the leakage parameter between the test groups ($p = 6.24E-22$). Additionally, Tukey’s comparisons indicated that both G1 (control) and G6 recorded comparable leakage possibility ($p=0.4332$). The leakage values of both groups were proved to be the lowest in comparison to other test groups. The leakage values of groups 3 and 5 were also comparable ($p=0.4332$) and lower than
groups 2 and 4. Leakage values of group 4 were the worse among all groups.

DISCUSSION

The purpose of retrograde sealing after apicectomy is to establish an effective barrier between the root canal and the periapical tissues.\(^{(25)}\)

In the current study, all the root canal preparation and obturation procedures were standardized and done by the same operator to decrease variability. Sodium hypochlorite was used as a canal irrigant because of its lubricant, antimicrobial, organic tissue dissolving properties\(^{(26)}\) but was not used as the final rinse as it may affect the sealer-dentin bond strength.\(^{(27)}\) Smear layer was removed to allow deeper resin sealer penetration into dentinal tubules thus improving the adhesion.\(^{(28)}\) Root canals were obturated with realseal points/realseal SE sealer (SybronEndo, Basicweg, Amersfoort, The Netherlands) that was previously marketed as Resilon-epiphany SE system (Pentron Clinical Technologies LLC, Wallingford, CT) which is a resinous material claimed to give monoblock obturation. Some in vitro and in vivo studies\(^{(29, 30)}\) proved an acceptable resistance of Epiphany sealer to bacterial leakage. It was also reported that this material can reinforce the obturated roots minimizing the chances of vertical root fracture.\(^{(31)}\)

Realseal SE has been tried as an apical seal in group 6 of the current study based on the finding that adhesives are usually used over composite retro-fillings for better sealability.\(^{(32)}\) The self-etch adhesives were also found less time consuming and less technique sensitive with better sealability.\(^{(33)}\) In addition, Maltezos,\(^{ et al.}, 2006\)\(^{(34)}\) observed good sealing results for Resilon and concluded that it might be used as retrograde filling material.

Compoglass F retro-filling was used as a control in this study as it has been proved to have better biocompatibility than ordinary glass ionomer cements and MTA and was suggested as the material of choice in root resorption, perforations, and root-end filling.\(^{(14)}\)

Root resection of 3 mm from root tip was done perpendicular to its long axis of the tooth as this reduces the apical ramification and lateral canals, thus decreasing the number of open dentinal tubules and leakage at the resected root end.\(^{(35-38)}\) The retro-cavity was prepared 2mm in depth to ensure effective light-curing of compoglass retrofilling.\(^{(39)}\)

Methylene blue dye linear penetration & Longitudinal sectioning of roots were performed for measurement of microleakage in this study as it enables the direct observation of the dye penetration and its penetration pattern.\(^{(40)}\) Also Methylene blue has a comparable molecular size to those small bacterial metabolic products, rapidly detected under visible light, water soluble, diffusible and hard tissue non-reactive.\(^{(41-43)}\) The recommended times of exposure to dyes in leakage studies have ranged from 2 hours to 30 days.\(^{(40)}\) In our investigation the teeth were left in the dye solution for 72 hours.\(^{(23)}\)

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* Significant (sig.) difference at P ≤ 0.05
The results of this study showed comparable sealability for both G.1 (obturation, immediate apicectomy and compoglass retrograde filling) and G.6 (apicectomy, obturation and coating the cut surface with SE sealer). These results were supported by findings of some previous studies which showed that, the direct application of a retrograde root seal may eliminate the need for preparing a retrograde cavity that might be difficult to prepare due to the limited access to the surgical field. Also it has been shown that preparing and filling a small concavity on the resected root face with composite resin and dentin bonding agent or light cure glass ionomer cement gave acceptable sealing ability than retrograde filled cavities. In addition, open dentinal tubules at the beveled root surface of apicectomized teeth may invite leakage and the authors advocated complete coverage of the resected surface with an adhesive retro-seal regardless the angle and extent of the bevel thus blocking these dentinal tubules. Moreover, Tanomaru-Filho et al., had come to a conclusion that, Epiphany may be an alternative as a retro-filling material.

The results also showed that both of G.3 (obturation, immediate apicectomy and apical light curing of exposed sealer) & G.5 (apicectomy, obturation and curing of the exposed sealer at the cut surface) are comparable to each other. This might be referred to the fact that each of them has a good chance for good condensation of realseal points and hence less sealer exposure at the apex and also get the benefit of light curing at the periapical area which accelerates the polymerization and sealer bonding to both the realseal points and the root dentin.

The better results for both G3 and G5 (light curing was done to the sealer at the exposed apical root end) compared to both G2 and G4 (no light curing to the sealer at the exposed apical root end) may be referred to the fact that the light curing improve the sealing through the formation of hybrid layer at the dentin-resin sealer interface. This is supported by the results of a study done by Hashimoto et al. who concluded a superior dentin sealing of a self-etch adhesive resin due to the retained hybridized smear plugs within the tubules.

G.2 (obturation, apicectomy after 24hrs with no further treatment) showed less than expected sealing ability because of some suggested reasons. The first is that this dual-cure resin sealer depends mainly on its chemical-cure components for polymerization in the apical region and the second is that the cutting stresses at the apex might have interrupted the apical bond between the sealer and the dentin wall resulting in more leakage.

This is supported by previous findings that proved that mechanical interruption of the sealer/realseal point/root dentin bond with a rotating cutting instrument might affect their apical seal. Additionally, despite the hybridization of resin-filling materials, a tight seal is difficult to achieve because of the complex anatomy and mechanical challenges such as polymerization shrinkage and unfavorable C-factor inside the root canals.

The least leak-proof results was for G.4 (obturation, immediate apicectomy with no further treatment) which might be due to the obvious fact that, the chemical curing reaction takes too much time compared to light activated cure giving a chance for sealer degradation and more leakage and this was confirmed by a study of Beriat et al., 2009 who came to a conclusion that, the amount of conversion of Epiphany was approximately 50% after photo-activation and improved by approximately 10% after 15 days. These results indicated weak polymerization of uncurled Epiphany which supports our results.

From the previous studies, it is clear that further in vivo histologic and microleakage studies are needed to assess the healing pattern(s) of the periapical tissue following the application of different treatment modalities suggested by the current study.

**Conclusion:**
Under the circumstances of this study we can conclude that, apical sealing with a self-etch adhesive sealer coat is an acceptable alternative to retrograde cavity filling in apicectomized roots obturated with resin-based system. Light-curing of the sealer exposed following apicectomy might improve the apical seal.

**Conflict of interest**
The author declares no conflict of interest.

**References:**


